PRESIDENT'S MALARIA INITIATIVE


Assessment of Residual Efficacy of Deltamethrin—Rwanda

Integrated Vector Management (IVM) Task Order 2

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RWANDA IRS PROGRAM TECHNICAL CONSULTANCY REPORT ON ASSESSMENT OF RESIDUAL EFFICACY OF DELTAMETHRIN (WG250) USED IN THE LAST ROUND OF IRS OPERATION IN TWO DISTRICTS.

(RTI NUMBER 0209356.002.600.009.002, contract number 8668)

8th March – 1st May 2010.CONSULTANCY REPORT

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List of Acronyms

RTI	Research Triangle International
PMI	President's Malaria Initiative
ITN"s	Insecticide Treated Bed Nets
IRS	Indoor Residual Spraying
USAID	United States Agency for International Development
IRSIQC	Indoor Residual Spraying Indefinite Quantity Contract
WHO	World Health Organization

Executive summary

The republic of Rwanda is one of the 15 countries benefiting from the President's Malaria Initiative (PMI) whose goal is to reduce deaths due to malaria by 50% and reaching 85% of the vulnerable groups with life saving services such as supply of curative drugs, IRS, Insecticide treated bed-nets and preventive treatment to pregnant mothers. The US Agency for International Development (USAID) which manages the program provides technical and financial support through RTI to implement the program in collaboration with national malaria control programs. In this regard RTI is engaged in implementing an indoor residual spraying (IRS) program in various epidemic prone districts with a view to reduce mosquito densities and disrupt malaria transmission.

Insecticide-based control measures (e.g. IRS and ITNs) are the principal way to kill mosquitoes that bite indoors. However, after prolonged exposure to an insecticide over several generations, mosquitoes, like other insects, may develop resistance, a capacity to survive contact with an insecticide. Since mosquitoes can have many generations per year, high levels of resistance can arise very quickly. Resistance of mosquitoes to some insecticides has been documented with just within a few years after the insecticides were introduced. This phenomenon, together with other factors such as spraying quality and low residual efficacy of insecticide in use may impact negatively to the success of IRS programs.

Hence a consultancy was awarded from 8th March to 30th April 2010 to assess the quality of routine monitoring in the sentinel villages by providing supervisory functions to mosquito identification, dissections for parity rates, support insectary functions by initiating the establishment of a susceptible and field colonies and conduct wall bioassays in selected sectors to assess residual efficacy of deltamethrin.

Results of wall cone bio-assay showed levels of susceptibility to deltametrin ranging between 44-100% within sectors, cell and villages. Statistical analysis using Kruska

Wallis method did not show significant differences when mortalities were ranked between cone positions (top, mid and bottom wall) P= 0.4738 > 0.05, neither was there significant differences in mortalities between substrates (mud, plastered painted, plastered not painted) P= 0.7064 > 0.05. However, there were significant differences when mortalities were ranked by sector P= 0.0001 < 0.05, by village P= 0.0001 < 0.05, by cell P= 0.0001 < 0.05 and by teams P= 0.0001 < 0.05. Overall wall bioassay showed100% mortality in 17% of the houses sampled, while in 51% of houses sampled, mortality ranged between 96-80% and in 25% of the houses, mortality was below 80%. Low levels of susceptibility observed could be as a result of insufficiency of deltamethrin on wall surfaces resulting from differences in insecticide application skills by different teams.

The two insectaries are still lacking some vital equipment and therefore establishment of susceptible and field colonies is still elusive. However the equipment will soon be installed as a process to purchase them from a Nairobi based supplier is underway. Monthly monitoring in the sentinel villages is continuing and dissections for parity rates started soon after the advanced training. It was observed that weather data is not currently being recorded in the sentinel villages although this would be an important component and if correlated to entomological factors would help in explaining upsurge of malaria incidence in some villages. It is recommended that a second data point be collected in the same houses which were sampled after the third month after spraying to determine whether deletamethrin is still efficacious on the wall surfaces.

1.0 Introduction.

1.1 Background;

The republic of Rwanda having an estimated 0.5 million malaria cases in children under five years, is among the countries in Africa benefiting from the President's Malaria Initiative. The 1.2 billion dollar program aims at cutting deaths due to malaria by 50% in 15 countries by reaching 85% of the population most vulnerable to the disease with life saving services, supplies and medicines. Key interventions supported by PMI include Indoor Residual Spraying (IRS) with insecticides, supply of insecticide treated bed-nets

(ITN), curative drugs and intermittent preventive treatment to pregnant mothers. Under the Indoor Residual Spraying Indefinite Quantity Contract (IQC), RTI was mandated to carry out IRS program with the collaboration of the Ministry of Health and National Malaria Control Pprogram in Rwanda and hence insecticide spraying activities started in malaria prone provinces in Kigali (Nyarugenge, Gasabo and Kicukiro districts) in August 2007. Similarly IRS activities have been extended to eastern province (Kirehe district) and southern province (Nyanza district). Towards the end of February 2010, two districts (Gasabo and Kicukiro) were re-sprayed with deltamethrin. Insecticide-based control measures are the principal way to kill mosquitoes that bite indoors. However, after prolonged exposure to an insecticide over several generations, mosquitoes, like other insects, may develop resistance, a capacity to survive contact with an insecticide. Since mosquitoes can have many generations per year, high levels of resistance can arise very quickly. Resistance of mosquitoes to some insecticides has been documented with just within a few years after the insecticides were introduced and therefore an understanding of insecticide resistance and how to manage it, is crucial if chemical control is to be used. The phenomenon of mosquitoes developing resistance, together with other factors such as low residual efficacy and spraying quality may have a negative impact to the success of IRS programs. Hence, RTI offered a consultancy to Mr. Encoh Mpanga to assess the residual efficacy of deltamethrin in selected sectors in Gasabo and Kicukiro ditricts.

1.2 Scope of Work

The purpose of this mission was to carry-out consultancy work on verifying residual efficacy of deletamethrin (WG 250) used in the last spraying operation in two districts (Gasabo and Kicukiro) and to support work in the sentinel sites. Specific activities are outline below.

- Support the work of the sentinel sites to initiate routine monitoring, including dissections of mosquito activities and provide supervisory functions to mosquito collection and identification.
- Support insectary functions, including the establishment of the susceptible and local colonies of mosquito vectors.
- Ensure the initiation of wall bioassay within selected IRS sectors to assess residual efficacy of insecticides.

Methodology

2.1 work in the sentinel sites

Five sentinel sites were visited Kicukiro (Kigali city), Bukora (Kirehe, Eastern province), Rukara (Kayonza district Eastern province), Busoro (Nyanza district, Southern province) and Karambi (Ruhango district, Southern province) to assess the quality of dissections (parity rates) and provide supervisory functions in mosquito collection and identification. Dissections on parity rates started in Kicukiro, Busoro and Karambi soon after the advanced training that was conducted in Mashesha. However in Bukora and Rukara, this activity had not been started as at the time of my visit since the mosquitoes collected at the time were *Culex* mosquitoes. However, field technicians in these two sites were advised to practice parity dissections with *Culex* mosquitoes in order to improve their dissection skills. In all the sentinel sites visited, field technicians were able to differentiate *Anopheles* species from *culex* species. However, some *Anopheles* species (A. *moucheti*) although rarely encountered was incorrectly identified as *A. gambiae*. I instructed the teams that all other *Anopheles* species encountered should be properly identified and documented as they maybe playing a role as secondary vectors of malaria transmission. The technicians were advised to refer to the hand-outs they received during the first training when identifying *Anopheles* species.

2.1 Rearing of field mosquito colony for use in wall bioassays

Immature mosquitoes (larvae and pupae) were collected from several larval habitats (road-side pools, tyre tracks and pits in sand excavation sites) in Gasabo district (Kabuye, Kicukiro and Jabana sectors) and reared to adult mosquitoes following the Standard Operating Procedure in the insectry based at Kigali to the Health Institute.. The following conditions of Relative humidity 60-70% and Temperature of 24-28^{0}c was maintained throughout the rearing period. 60% sucrose solution was provided to emerging adults. Adults *Anopheles* mosquitoes were identified as *Anopheles gambiae s.l* by observing their morphological characteristics (Gillet D 1972).

2.3 Wall bio-assays;

After one month of spraying operation, a sample comprising 39 houses in two districts (Kicukiro and Gasabo) were used for wall bioassay. Houses were selected to represent three different substrates (mud, plastered painted and plastered not painted). Five sectors (Jali, Ndera, Nduba Gatsata and Bumbogo) were selected in Gasabo district and similarly two sectors were selected (Masaka and Kanombe) in Kicukiro district. Please note that districts are made up of several sectors, in turn sectors are made up of several cells and villages are smaller units making up cells. Only houses with IRS stickers showing spraying dates were used for bioassays. In Bahoze village, mud houses were skipped due to improved houses while in Gatsata, occupants of mud houses were not available.10 unfed, 2-5 days old *A. gambiae* mosquitoes were transported into plastic cups placed in humid chamber (cool box). They were transferred in plastic cones fixed in three positions (top half of the wall, mid-wall and bottom wall) and exposed for 30 minutes. At the end of the exposure time, mosquitoes were aspirated into labelled (house type, position of cone, exposure date, sector, cell and village) paper cups and fed on 60% sugar solution and maintained in the insectary for 24 hours at between 25-27 ^{0}C and 65-70% RH. Paper cups were checked for mortalities and % mortalities calculated after 24 hours.

3.0 Data analysis;

Results of the bioassay tests were determined according to WHO criteria (WHO 1998). If mortality exceeded 20% in the control, the whole test was rejected. If mortality in the control exceeded 5%, the results of the treated samples were corrected using Abbot's formula (W.S Abbott 1925).

$$\text{Mortality\%} = \frac{X - Y}{100 - Y} \times 100$$

Where X = mortality % in test samples, Y= mortality % in control.

Statistical analysis using Kruska Wallis method (non parametric) was used to rank means on, 1- mortality on three substrates (mud, plastered unpainted and plastered painted walls), 2- mortality on different cone positions (top, mid and bottom wall) 3- mortality by village, 4- mortality by sector, 5- mortality by cell.

3.1 Results;

Sentinel sites;

Table1. Diversity of *Anopheles* species in the sentinel sites

Kicukiro	Busoro	Karambi	Bukora	Rukara
Anopheles gambiae s.l *Anopheles ziemanni* *Anopheles coustani*	*Anopheles gambiae sl* *Anopheles coustani* *Anopheles ziemanni*	*Anopheles gambiae sl* *Anopheles moucheti* *Anopheles ziemanni*	*Anopheles gambiae sl* *Anopheles coustani*	*Anopheles gambiae* *Anopheles moucheti* *Anopheles coustani*

Wall bioassay

The overall % mortality in two districts is shown in Table 2 and attached as Appendix 1. Statistical analysis ranking mortalities on different substrates did not show significant differences, Chi-square = 0.695, df = 2, P = 0.7064 > 0.05. Similarly, there was no significant difference when mortalities were ranked for different wall positions, Chi-square = 1.494, df = 2, P = 0.4738 > 0.05. Since there was no significant differences observed on cone position and substrate type, mean mortalities were calculated by village, cell and sector and when ranked showed significant differences. By **sector** Chi-square= 30.935, df = 6, P = 0.0001 < 0.05, **cell** Chi-square = 31.394, df = 7, P = 0.0001 < 0.05, and **village** Chi-square = 37.764, df = 10, P = 0.0001 <0.05.

6.0 Observations and recommendations

Successful studies on susceptibility/resistance of mosquitoes in Rwanda would require establishment of a field and a susceptible mosquito colony. It is encouraging that RTI has taken the initiative to set up two insectaries that will be equipped with facilities that enable successful rearing of mosquitoes. These will be ready soon when the remaining equipments are installed. Weather data in the sentinel sites is not recorded due to lack of equipment. This data is an important component that will help in explaining malaria upsurge in some villages when correlated with entomological factors. Data from monthly monitoring is still recorded and stored as hard copies, even though each sentinel site is equipped with a computer. Results of the wall bioassay showed100% mortality in 17% of the houses sampled, while in 51% of houses sampled, mortality ranged between 96-80%

and in 25% of the houses, mortality was below 80%. These differences could be as result of spraying quality by different spraying teams. However, insecticide quality was not ascertained since only a field colony mosquitoes were used for bioassays. This should be completed by use of a susceptible colony.

Recommendations

1- Weather data collectors (Hobo) suitable for field placement and capable of recording both temperature and humidity should be purchased for each sentinel site.
2- Two people should be recruited to work on full time basis in the two insectaries.
3- Retraining of spraying teams should be undertaken to improve quality of spraying.
4- Technicians in the sentinel sites should start using computers for data entry (monthly monitoring data) to create a data base and for easy analysis.
5- Wall bio-assays should be repeated after the third month to ascertain residual efficacy of deltamethrin on wall surfaces.
6- The residual efficacy imposed 100% mortality in only 17% of the houses sampled. Supervisors should monitor working practices of spray-men to ensure that perfect skills are achieved during spraying.

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